Chemeca 2025 and Hazards Australasia
28 – 30 September, Adelaide, South Australia

Effects of Simulated Reduced Gravity on Ethanol Fermentation with Saccharomyces Cerevisiae

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ABSTRACT

Bioprocessing is pivotal for humanity to become a space-faring civilisation. There exists an inherent limit to the distance and duration of life-supporting space missions because some mission-critical resources are finite. This is why the need for extra-terrestrial settlements to engage *in situ* resource utilization is widely accepted. To succeed, a civilisation must be able to generate food and fuel, along with manage its waste; all of which could be achieved through harnessing a bioprocess like fermentation. And because fermentation could be performed *in situ*, investigating its behaviour and efficacy in the space environment becomes a priority.

Many factors influence the fermentation process. Most of which are familiar and can be tested terrestrially. Gravity, and the reduction or lack of this force, is both difficult to investigate and often irrelevant to terrestrial fermentation. Understanding how a change in gravity affects fermentation is important for fermenter design beyond-Earth as many gravity-dependent phenomena like mixing, settling, bubble dynamics, and intracellular forces are likely to be altered. Which, in turn, are likely to alter key process parameters such as yield and quality.

This study macroscopically investigates alcoholic fermentation by model organism *S.cerevisiae* in a simulated space environment. It aims to provide a controlled and replicable methodology to observe and quantify effects of the reduced-g environment on the process and determine any initial changes to key process parameters such as yield and quality by comparing against terrestrial models. The concentration of viable cells, substrate, product will be collected to determine model kinetic constants. The study will use a Random Positioning Machine as the mechanism as a practical way to simulate a reduction in gravitational force across Martian, Lunar, and micro- scenarios. The magnitude of effect the RPM may have on the process will also be discussed. Experimental conditions of agitated and still, in tandem with perpendicular and parallel to the agitation axis, aim to encompass the range of possible fluid environments for the RPM conditions.

KEY WORDS

Fermentation, Microgravity, Space, ISRU

BIOGRAPHY

Lachlan graduated from the University of Adelaide in 2022 with a Bachelor of Engineering (Chemical)(Hons 1st) and started a PhD in Chemical Engineering in 2023. Keen to share and promote

the importance of chemical engineering in space, Lachlan presented his ideas at Chemeca 2023, the 2nd International Asteroid and Small Bodies Symposium Workshop, and was awarded 1st place in the 2024 SCE HDR Conference 3-minute thesis presentations.
He has been an affiliate researcher with the Andy Thomas Centre for Space Resources since the beginning of his PhD and hopes to continue with chemical engineering and space as a postdoctoral researcher.

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